MSO26 OPTICAL AND STRUCTURAL PROPERTIES OF InAlN/GaN BRAGG REFLECTORS EXAMINED BY TRANSMISSION ELECTRON MICROSCOPY AND ELECTRON ENERGY LOSS SPECTROSCOPY

A. Eljarrat[1], Ž. Gačević[2], S. Fernández-Garrido[2,5], E. Calleja[2], C. Magén[3,4], S. Estradé[1], F. Peiró[1,6]

[1]Laboratory of Electron NanoScopies, LENS-MIND-IN2UB, Dept. Electrònica, Universitat de Barcelona, Spain

[2]Instituto de Sistemas Optoelectrónicos y Microtecnología, ISOM, Universidad Politécnica de Madrid, Spain

[3]Laboratorio de Microscopías Avanzadas (LMA) - Instituto de Nanociencia de Aragón (INA) and Departamento de Física de la Materia Condensada, Universidad de Zaragoza, 50018 Zaragoza, Spain.

[4]Fundación ARAID, 50018 Zaragoza, Spain.

email: aeljarrat@el.ub.es

Molecular beam epitaxy growth of ten-period lattice-matched InAlN/GaN distributed Bragg reflectors (DBRs) with peak reflectivity centered around 400nm is reported including optical and transmission electron microscopy (TEM) measurements [1]. Good periodicity heterostructures with crack-free surfaces were confirmed, but, also a significant residual optical absorption below the band-gap was measured. The TEM characterization ascribes the origin of this problem to polymorfism and planar defects in the GaN layers and to the existence of an In-rich layer at the InAlN/GaN interfaces. In this work, several TEM based techniques have been combined. First, selected area electron diffraction (SAED) and high resolution transmission electron microscopy (HRTEM) have been used to determine epitaxial relationships between InAlN, GaN and sapphire layers. Besides the expected orientations, (0001)[0110]Al_2O_3||(0001)[1120]GaN and (0001)[1120]InAlN||(0001)[1120]GaN, HREM revealed the coexistence of zinc-blende and wurtzite phases in the GaN semiperiods. High angle annular dark field (HAADF) imaging in scanning-TEM mode, revealed the presence of an-In rich layer,underneath the InAlN semiperiod. Finally, high resolution monochromated electron energy loss spectroscopy (EELS), with an energy resolution better than 200 meV, was applied to analyse chemical composition variations in the GaN-InAlN interface through the plasmon position measurement. Moreover, dielectric functions obtained through Kramers-Kronig Analysis (KKA) helped confirm the polymorfic nature of GaN layers at nanoscale. Analysis of the valence-EELS data through zero-loss-peak subtraction and deconvolution techniques, non-linear curve fitting or KKA, amongst others, allows us to assess other optoelectronic properties of the DBR, such as the band gap transition in the layers, or the impact of retardation losses on GaN.

[1] Ž. Gačević, S. Fernández-Garrido, D. Hosseini, S. Estradé, F. Peiró, E. Calleja Journal of Applied Physics, 108 (2010) 113117.

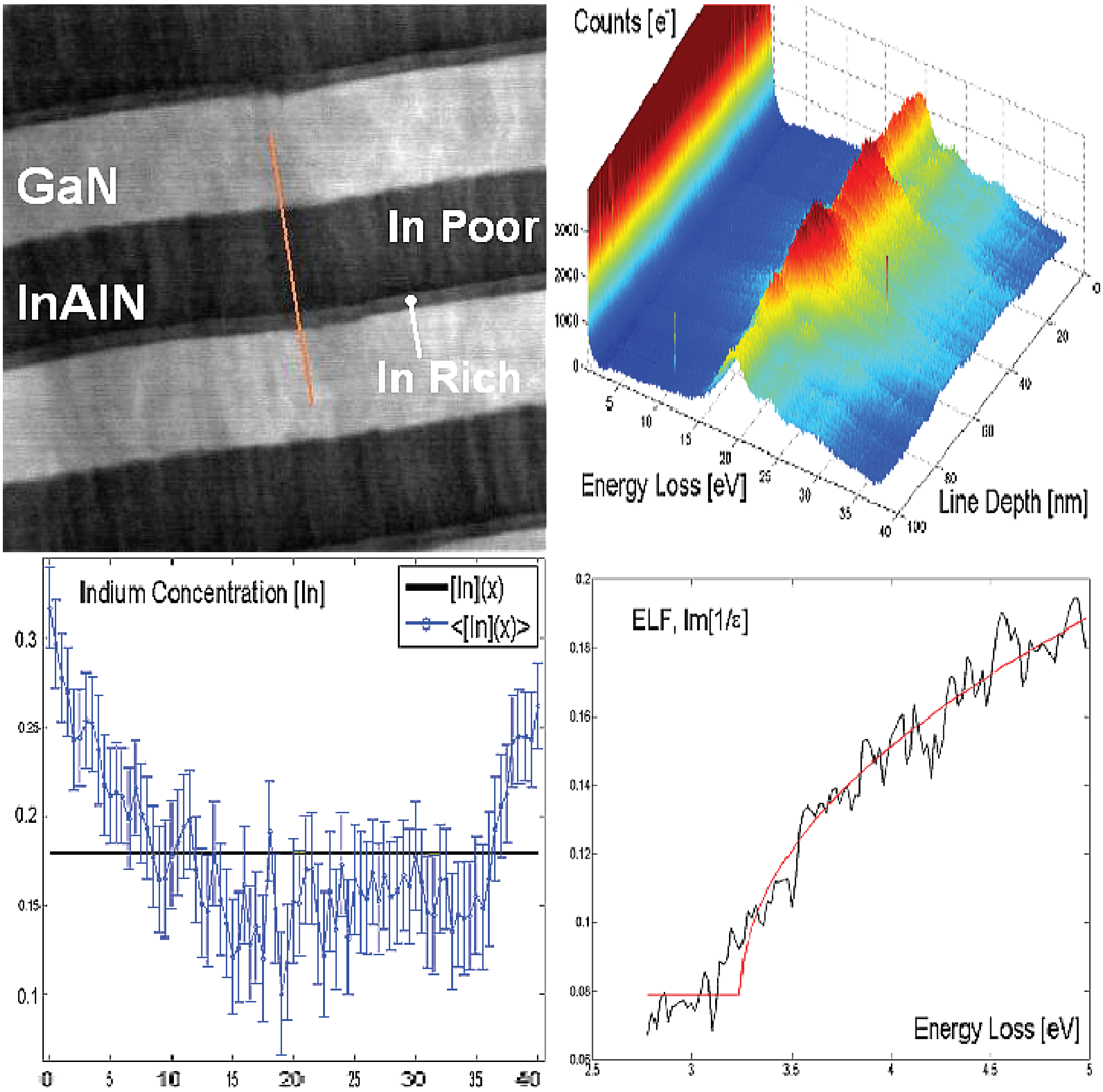

Figure 1. Optoelectronic and structural analysis is performed on the basis of low loss Valence-EELS data. Top panels: STEm-HAADF image and associated spectrum line. Bottom panels: Indium concentration at InAlN layer calculated assumingVegard's Law and square root fit to band gap signal onset on KKA-calculated energy loss function (ELF).